



Selecting power cords and jumper cables for use with HP ProLiant and BladeSystem servers

technology brief, 3rd edition



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Abstract

Utility AC power standards for connector types and voltage levels vary from country to country. HP provides a variety of power cords, jumper cables, and accessories that facilitate using HP ProLiant and BladeSystem servers and options around the world. This technology brief describes the various types of power cord and jumper cable assemblies HP provides and explores cable management in rack installations.

Introduction

Most HP ProLiant servers feature auto-sensing power supplies with a power input range of 100 – 240 VAC, so they can be used globally with either a low-line or high-line utility service. HP power cords meet the standards for the country for which they are intended. Rack-mountable HP servers are usually shipped with IEC-to-IEC jumper cables. Some installations may require optional cable assemblies and cable retention devices. This paper identifies connector types, power cords, cable assemblies, and cable retention accessories available for use with HP ProLiant servers.

Cord and cable assemblies

Power cord and jumper cable assemblies are available for HP ProLiant power supplies.

- Plug – Male connector for insertion into the AC outlet providing power. The physical design and layout of the plug's contacts meet a specific standard.
- Cord – Main section of insulated wires of varying length and of a thickness determined by its current rating
- Receptacle – Female connector that generally attaches to the equipment. The physical design and layout of the receptacle's contacts meet a specific standard. The most common are the IEC C13 receptacle for loads up to 10 amperes (A) and the IEC C19 receptacle for loads up to 15 A.

Figure 1. Power cord assembly

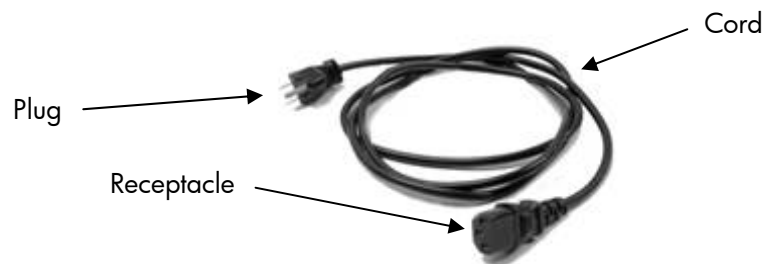


Figure 2 illustrates profiles of worldwide AC plugs. Table 1 identifies the country or countries in which each plug type is used.

Figure 2. Worldwide AC plug profiles

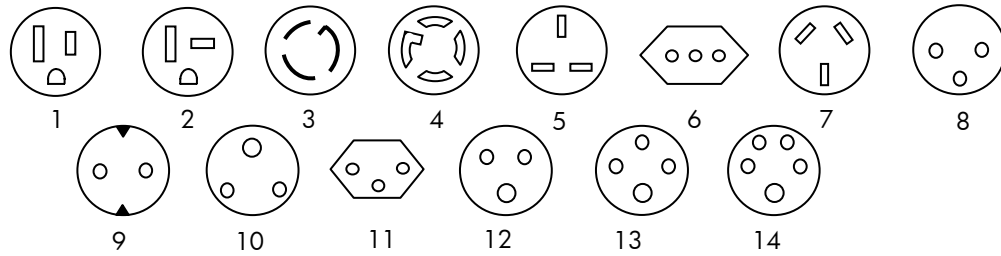


Table 1. Worldwide AC plug types

Primary region or country	Voltage Rating (VAC)	Current rating (amperes)	Plug type	Plug profile in Figure 2	Notes
N. America	100 - 127	15	NEMA 5-15P	1	[1]
N. America	100 - 127	20	NEMA 5-20P	2	
N. America	200 - 240	20	NEMA L6-20P	3	
N. America	200 - 240	30	NEMA L15-30P	4	[2]
UK, Hong Kong, Singapore	200 - 240	13	BS-1363	5	[3]
Argentina	200 - 240	10/15	IRAM 2073	7	
Australia, New Zealand	200 - 240	10/15	AS-3112	7	
Brazil	200 - 240	10/20	Nema 5-15P	1	
China	200 - 240	10/16	GB-1002	7	
Denmark	200 - 240	10	DK 2-5	8	
Europe	200 - 240	16	CEE 7/7	9	[4]
India	200 - 240	6/16	IS-1293	10	[5]
Israel	200 - 240	10/16	SI-32	8	
Italy, Chile	200 - 240	10/16	CEI 23-50	6	
Japan	100 - 127	12	JIS C8303	1	
S. Africa	200 - 240	10/16	SABS-164	10	
Switzerland	200 - 240	10	SEV 1011	11	
Taiwan	100 - 127	12/16	CNS 690	1	
International	200 - 240	20	IEC 309	12	[6]
International	200 - 240	20	IEC 309	13	[7]
International	200 - 240	30	IEC 309	14	[8]

NOTES:

[1] Also used for 200 - 240 VAC applications in Korea and The Philippines

[2] Three-phase AC

[3] Also Malaysia, and Ireland

[4] Also known as "Schuko" connector and used in Austria, Belgium, Finland, France, Germany, Greece, Hungary, Indonesia, The Netherlands, Norway, Poland, Portugal, Russia, Spain, and Sweden

[5] Supersedes type BS 546


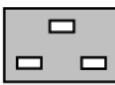
[6] 3-wire (two-phase and earth). Physical variations (connector size/color) indicate amperage rating. Used in Switzerland for a true 16A application.

[7] 4-wire (three-phase and earth). Physical variations (connector size/color) indicate amperage rating.

[8] 5-wire (three-phase, earth and neutral). Physical variations (connector size/color) indicate amperage rating.

Power supplies for HP ProLiant servers have a chassis-mounted IEC C14 or IEC C20 AC input connection. Table 2 lists the types of AC connections on specific HP ProLiant servers.

Table 2. Power connections on HP ProLiant servers (current models)

ProLiant Model	AC input connection provided
DL100 series DL300 series DL580 series DL785 series ML100 series ML300 series SL6000 series	IEC C14 
DL585 series ML500 series c-Class blade enclosure [1] p-Class 1U power enclosure [2]	IEC C20 

Notes:

[1] Chassis connector shown for single-phase AC enclosure. Three-phase AC enclosure includes a pair of power cords with the choice of either NEMA L15-30P or IEC 309 connectors.

[2] 3U enclosure includes a pair of power cords with the choice of either NEMA L15-30P or IEC 309 connectors.

NOTE

ProLiant G6 servers currently ship with one C13-to-C14 jumper cable assembly per power supply. Connection to a local AC outlet requires an optional country-specific power cord for each power supply.

Jumper cable and fixed cord assemblies

The jumper cable assembly (Figure 3) provides a power interconnect between the active component, such as a server, and a power distribution device such as a power distribution unit (PDU), an uninterruptible power supply (UPS), or an extension strip. Jumper cables are also available as a fixed cord extension strip, which combines jumper cables and an extension bar into an integrated component for orderly power distribution in high-density installations.

Figure 3. Jumper cable and fixed cord assemblies

Jumper cable assembly

















Fixed cord extension strip



Table 3 is a partial list of jumper cables and fixed-cord assemblies available from HP. All jumper cables implement IEC-type connectors and are rated for either low-line (100-120 VAC) or high-line (200-240 VAC) power.

Table 3. HP jumper cable and fixed-cord assembly types (partial list)

Product Description	Plug (male) end	Receptacle (female) end	Special notes
NEMA 5-15P-to-C13 jumper cable assembly			For use with PDUs or UPSs with NEMA outlets
C14-to-C13 jumper cable assembly			Currently supplied with all ProLiant G6 servers (one per power supply)
C14-to-C15 jumper cable assembly			
C14-to-C19 jumper cable assembly			For use only with ProLiant DL585 G5 servers running on high-line power
C20-to-C19 jumper cable assembly			
C20-to-C13 (x4) fixed cord extension bar			For connecting ProLiant SL6000 G6 servers to PDU core
C20-to-C13 (x7) fixed cord extension bar			

NOTE: For a complete list of HP jumper cable assembly option kits available from HP, go to:
<http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/options/power-cable.html>

Power cord/jumper cable use

HP server products are shipped with power cords or PDU jumper cables. All HP ProLiant G6 servers intended for rack installation ship with a high-line PDU jumper cable for each power supply. Installation and service requirements may require additional cords/cables to be ordered. HP provides a number of options for connecting server products to utility power. The type of power cord assembly required by a given installation will be determined primarily by the type of AC line feed (connector) provided by the facility. The type of jumper cord or fixed cord extension strip assembly required can be affected by several factors:

- Model (and generation) of server
- Type of PDU (modular or monitored) to be used
- Serviceability of components to be connected

The following sections describe typical cabling scenarios for HP ProLiant servers.

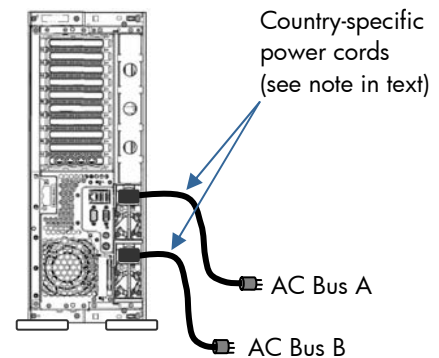
Cabling for low density systems

Servers in a tower configuration require a country-specific power cord for direct connection to a facility AC feed. However, server availability goals can require providing redundant AC power to the server in the form of a redundant AC bus or a UPS.

Figure 4 illustrates an HP ProLiant ML370 G6 tower server receiving redundant AC power. The ML370 G6 server includes two common-slot power supply bays. It can be configured for 1 + 1 power supply redundancy and connected to two AC buses using optional country-specific power cords. Should one bus fail, the remaining active bus and the redundant supply can continue to power the server.

If redundant AC buses are not available, the UPS is a convenient solution for backup power. Figure 5A illustrates an HP ProLiant ML370 G6 server connected to an HP international T1500 G3 UPS with a C13-to-C14 jumper cable assembly. Figure 5B illustrates an HP ProLiant ML370 G6 server connected to the T1500 G3 UPS model for use in North America and Japan. In both configurations, if AC power to the UPS is lost, the T1500 UPS can support the full load required by the server.

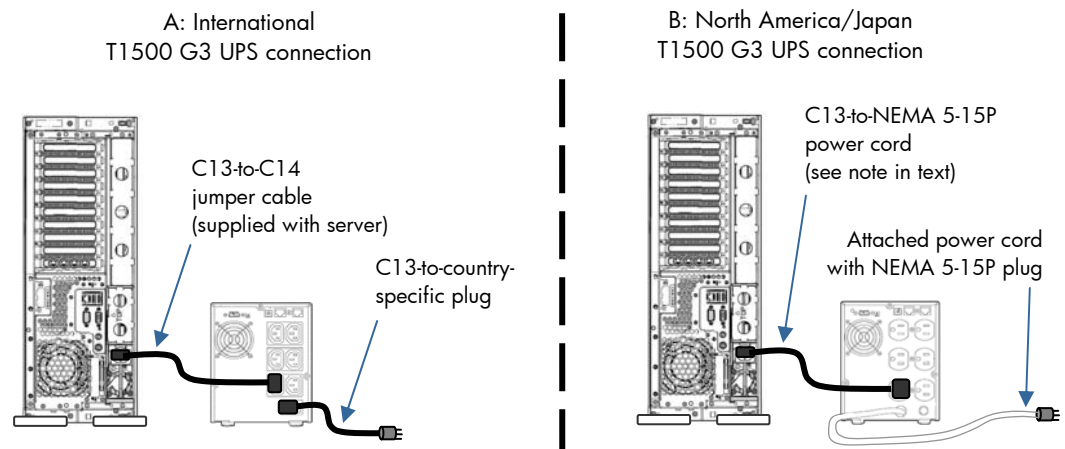
Figure 4. HP ProLiant ML370 G6 tower server with 1+1 power supply redundancy



NOTE

ProLiant G6 servers currently ship with one C13-to-C14 jumper cable assembly per power supply. Connection to a local AC outlet requires an optional country-specific power cord for each power supply.

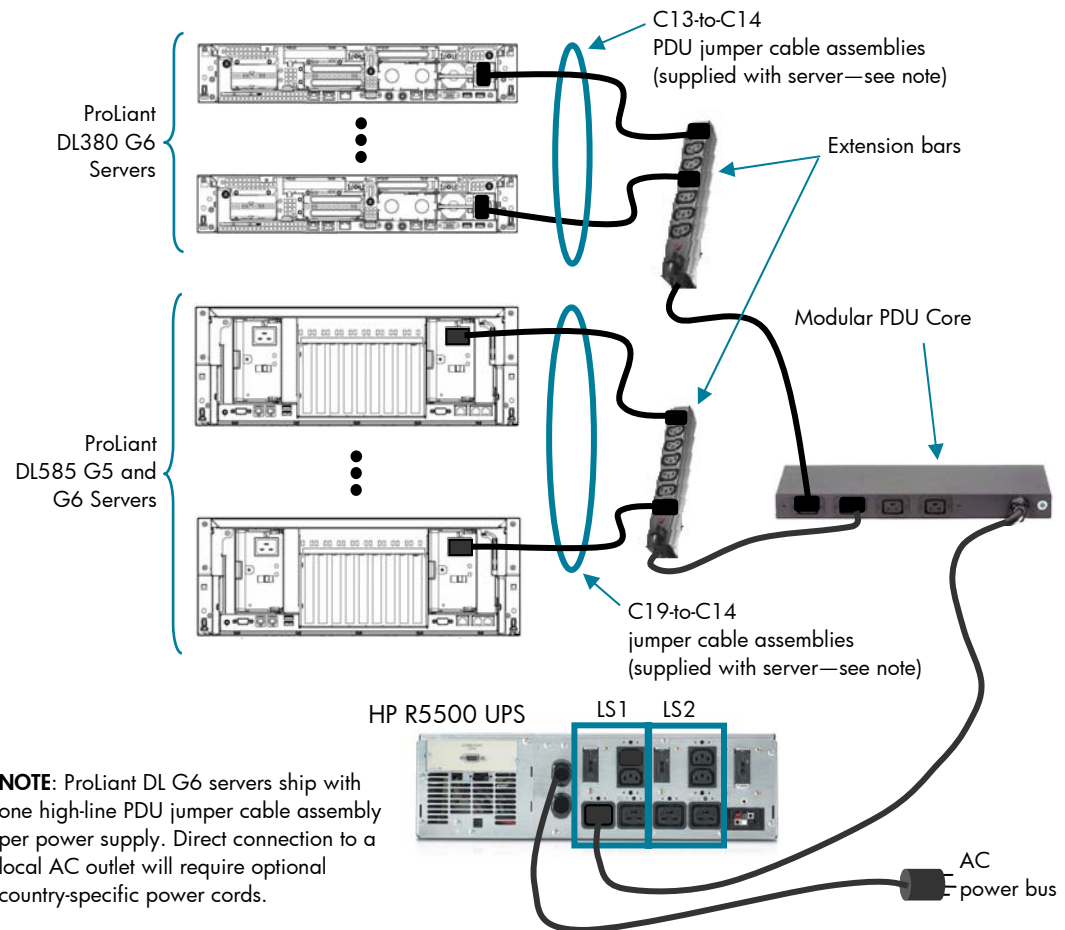
Figure 5. HP ProLiant ML370 G6 server connected to an HP T1500 G3 UPS



Cabling for medium-density systems

Figure 6 shows a system configuration with rack-mounted ProLiant servers connected to AC power through an HP Modular PDU and an HP R5500 UPS that provides segmented power distribution. The Modular PDU core and extension bars (available separately or as a complete set) support a variety of mounting strategies. The Modular PDU core, for instance, can be mounted in a zero U orientation on the side of the rack. The ProLiant DL380 and DL585 servers contain hot-pluggable fans accessible by sliding the chassis out on rails. This means the power cords or jumper cables connecting to the servers must have adequate length and slack to allow chassis movement while staying connected and powered up.

Figure 6. Power connection for ProLiant DL380 and DL585 servers using an HP Modular PDU, Extension Bars, and HP R5500 UPS (rack not shown for clarity)



The example in Figure 6 provides flexible load segmenting: The UPS offers two load segments (LS1 and LS2). The Modular PDU core provides four segments (each with an extension bar). Figure 6 shows power distribution from a single source—the HP R5500 UPS.

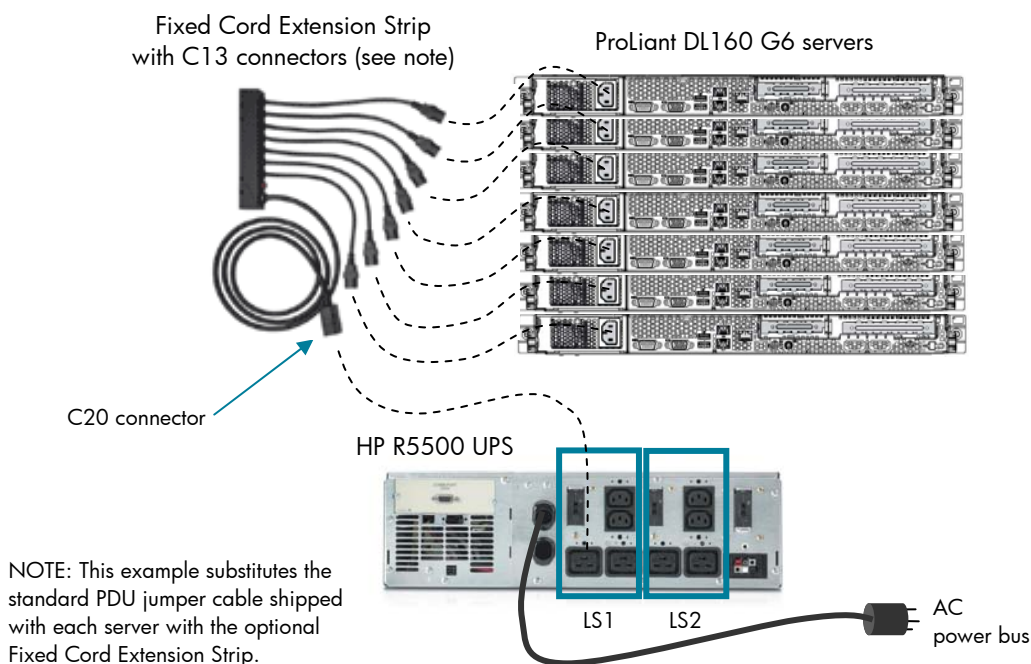
Cabling for high-density systems

High-density server systems employing 1U enclosures or server blades require power cabling strategies with a different approach. The designs of these systems allow replacing critical, hot-pluggable components without removing the chassis from the rack (and in some cases, without even extending the chassis from the rack). Power cords or jumper cables for these systems can therefore be short since cable movement is of little or no consideration.

Cabling for a ProLiant DL160 system

Figure 7 shows a suggested method of connecting rack-mounted ProLiant DL160 servers to AC power. The DL160 server uses a 1U form factor, and all hot-pluggable components are accessible from the front panel. Since the chassis need not be extended from the rack while operating, short power cables can be used. The Fixed Cord Extension Strip provides simplified, short-distance cabling for up to seven components.

Figure 7. Power connections for HP ProLiant DL160 G6 enclosures using the HP R5500 UPS and a Fixed-Cord Extension strip (rack not shown for clarity)



The ProLiant DL160 server provides a single C14 power inlet and has no internal provision for redundant AC power. Redundant AC power can be provided by connecting the Fixed Cord Extension Strip to a UPS as shown in Figure 7. Using the HP R5500 UPS, administrators can divide equipment loads into two load segments (LS1 and LS2). Figures 6 and 7 show the server load connected to LS1. To be redundant, the server load should be evenly divided between the segments and should not total more than the UPS maximum (for the HP R5500 UPS, 5500 VA).

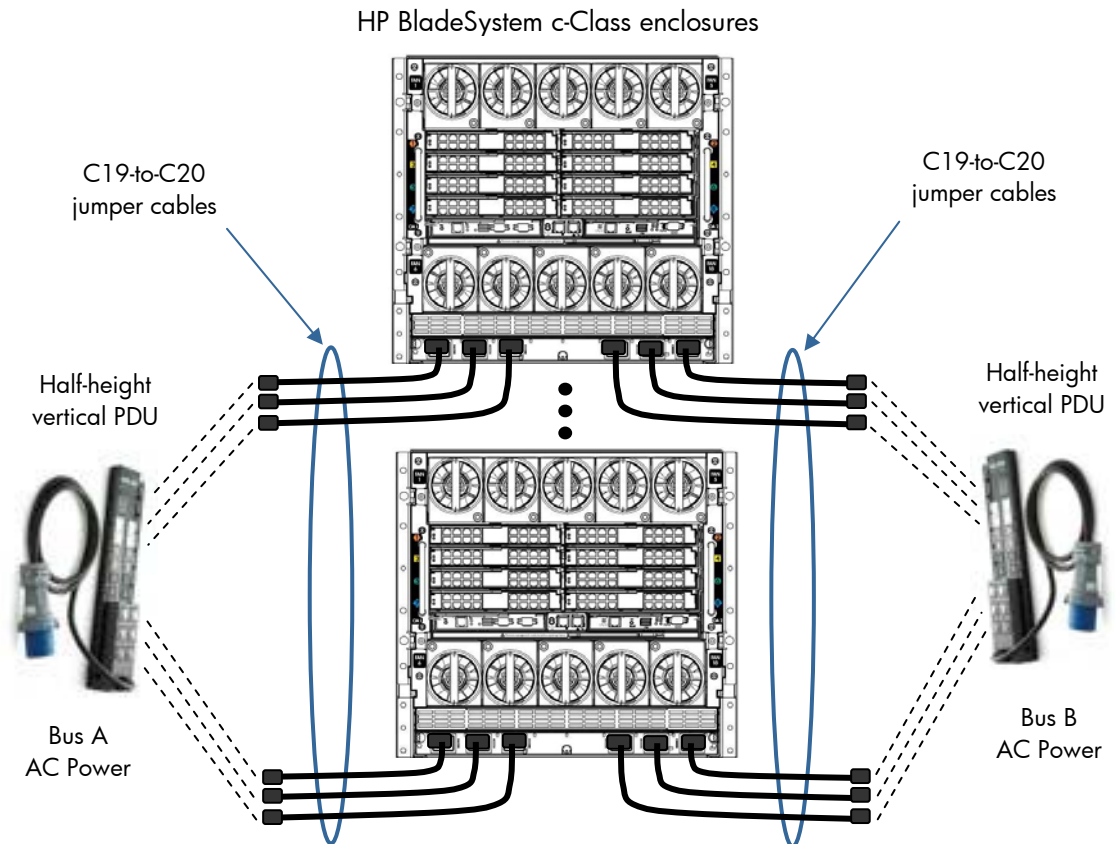
Cabling for an HP BladeSystem c-Class system

Figure 8 shows a suggested power cabling strategy for a rack containing several HP BladeSystem c-Class enclosures. Almost all replaceable components (server blades, interconnects, power supplies,

and fans) of the c-Class enclosure are hot-pluggable and replaceable with the chassis inside the rack and with systems operating. Therefore, power cables to the enclosure can be short and direct.

The HP half-height vertical PDU is well suited for providing power to HP BladeSystem c-Class enclosures in locations where rear rack space is limited. A rack extension kit available from HP may be necessary for some installations.

Figure 8. Power connection for HP BladeSystem c-Class enclosures using HP half-height vertical PDUs (rack not shown for clarity)



The example in Figure 8 uses the C20 outlets of the vertical PDUs and represents a system using redundant AC power (Bus A and Bus B) and load segmenting. BladeSystem c-Class enclosures support flexible power strategies and not all require the maximum of six power connections.

CAUTION

High-density systems can place significant current loads on PDUs and UPSs. HP recommends using the HP Power Advisor and Rack and Power Sizer utilities for calculating the total current (amperage) and apparent power (volt-amps) that a PDU or UPS will need to handle. See the [“For More Information”](#) section of this paper for links to the HP online calculators.

Cabling for extreme-density systems

The HP ProLiant SL6000 series servers are optimized for extreme scale-out computing applications requiring careful power distribution planning. The enclosure for HP ProLiant SL6000 servers accommodates up to two hot-pluggable, common-slot power supplies and comes standard with one power cord per supply for connection to a PDU.

Figure 9 shows several methods for connecting SL6000 enclosures to AC power. The upper area of the figure shows the use of C13-to-C14 PDU jumper cable assemblies for connecting single-supply SL6000 servers to a vertical mount PDU, a method suitable for lower-density installations. The central area of Figure 9 shows the use of C13 x4-to-C20 fixed cord extension bars, a method recommended for extreme-density installations using redundant power supplies. The bottom area of Figure 9 shows the use of a C13 x2-to-C20 Y-cable assembly recommended for connecting an SL6000 with dual 1200-watt power supplies directly to a PDU core with C19 outlets.

Figure 9. Power connections for ProLiant SL6000 enclosures (rack not shown for clarity)

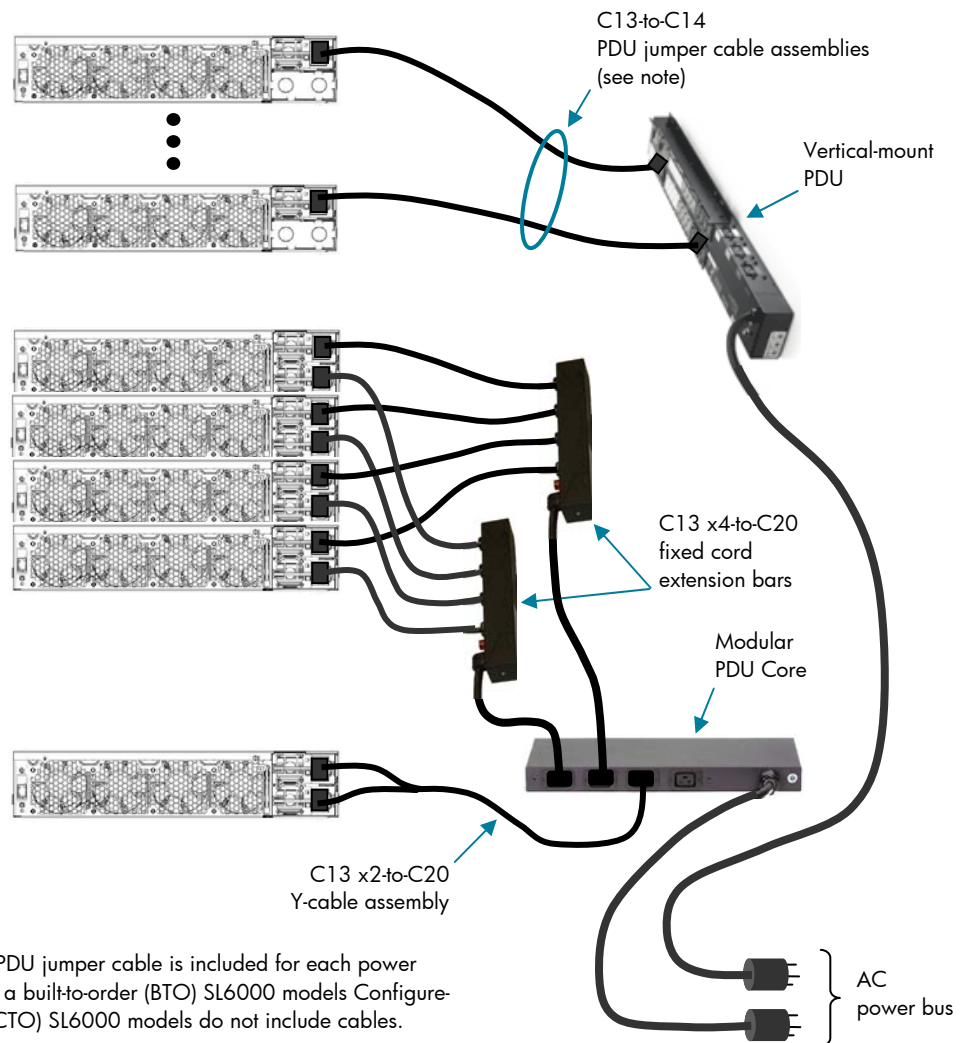


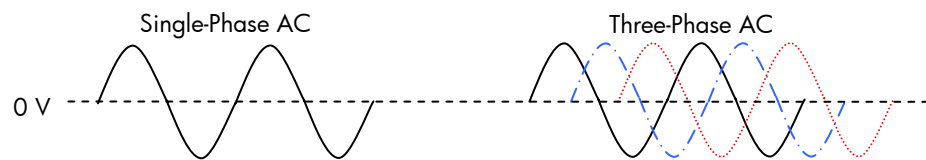
Figure 9 shows only a few power connection methods. Extreme-density installations can involve a variety of power distribution and power redundancy solutions.

Three-phase power considerations

As power requirements for server racks increase, the benefits of using three-phase power at the rack level become more significant. Strictly speaking, IT equipment does not use three-phase power.¹ The benefits of three-phase power are in its distribution.

Figure 10 shows the difference between single- and three-phase waveforms. With single-phase power, at any given time the voltage across the hot and neutral conductors can be anywhere between its peak (maximum) and zero. Electrical conductors must be large to meet high amperage requirements. Three-phase power uses three cycles that are 120 degrees out of phase, which never allows the voltage to drop to zero. The more consistent voltage derived from the three hot conductors results in smoother current flow and allows using smaller-gauge conductors to distribute the same amount of AC power.

Figure 10. Comparison of single-phase and three-phase AC voltage waveforms



The load balancing and increased power handling capabilities of three-phase distribution can result in more efficient (that is, less costly to run) installations requiring fewer AC cables and PDUs.

Cable management

Rack installations should be planned for operational efficiency as well as ease (and safety) of maintenance. HP offers cable management solutions that can relieve the cord/cable congestion often created when populating a rack with servers, power distribution units, and uninterruptible power supplies.

Cable retention

Accidentally unseating or unplugging a power cord can seriously affect the operation of an enterprise system. Unlike data cables, most power cord connectors do not have built-in retention mechanisms to prevent this from happening. However, HP offers cable retention devices and provides retention devices with some power distribution products. The rubber pull strap shown Figure 10, for example, loops around the neck of a power cord connector, and the notched tail is slipped over the hook of the restraining bar that is fixed to the vertical PDU.

Figure 11. Rubber hook cord retention

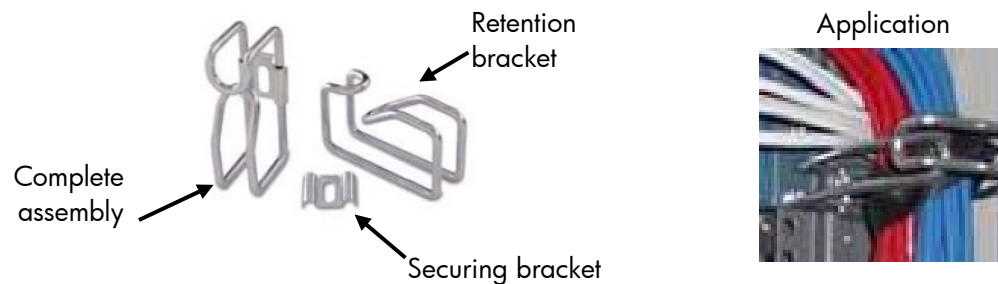


¹ HP BladeSystem c-Class and p-Class systems include chassis configurations that connect directly to three-phase power, but operation of the individual internal power supplies is single-phase.

Universal cable management kit

Customers can use the universal cable management kit for containing any type of cord or cable including power, network, or keyboard/video/mouse (KVM) cables. Each D-ring (Figure 12) mounts with a single clip that can be attached to various places, including cabinet mounting rails and some cable retention arms.

Figure 12. D-Type Cable Management Kit

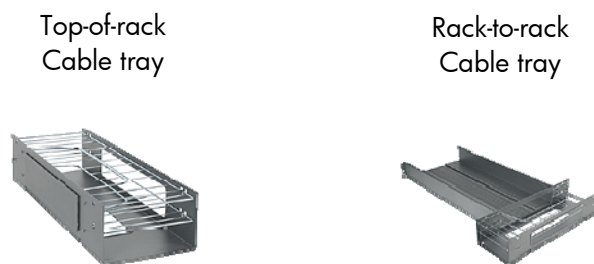


Cable trays

Cable trays protect bundled cords and reduce unsightliness for racks where cable density is high. Both inter-rack and intra-rack trays (Figure 13) are available.

For more information about cable management accessories and methods, refer to the associated link provided in the "[For more information](#)" section of this paper.

Figure 13. Cable trays



Conclusion

While HP products ship with the basic components needed to sufficiently power and run the system, certain installations and locations may require additional accessories and pieces. HP offers many solutions to facilitate a safe, reliable, and efficient server installation.

For more information

For additional information, refer to the resources listed below.

Resource description	Web address
HP power cord kit listing (North America and world-wide)	http://www.hp.com/products/powercords
HP Rack and Power infrastructure (main page)	http://h18004.www1.hp.com/products/servers/platforms/rackandpower.html
HP Tower UPS products	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/towerups/index.html
HP Rack UPS products	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/rackups/index.html
HP PDU products	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/pdu.html
HP Power Cord kit listing (North America and world-wide)	http://h18004.www1.hp.com/products/servers/proliantstorage/power-protection/options/power-cable.html
HP cable management and rack options	http://h18004.www1.hp.com/products/servers/proliantstorage/rack-options/list.html
PDU power cord and jumper cable assemblies	http://h18004.www1.hp.com/products/servers/proliantstorage/bcs-rackandpower/power-management/cordsets.html
HP online Power Advisor for ProLiant servers	http://www.hp.com/go/hppoweradvisor
HP Rack and Power Sizer	http://hp.exaltsolutions.com/exalt/RequestManager?ServletNumber=1&localinfo=30&RestrictionVal=SVG&APPLICATIONCODE=1
Additional rack and power information sources	http://h18004.www1.hp.com/products/servers/technology/whitepapers/datacenter.html

Call to action

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